Plasma &
Flame Spray
Engineering

GTV Verschleißschutz GmbH

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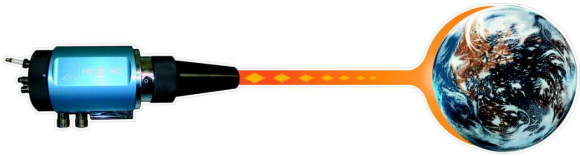

OPERATORS MANUAL

GTV HVOF K2 Burner

780.000

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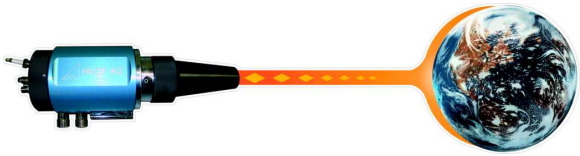

EG - DECLARATION OF CONFORMITY

According to EG- Machine Guideline 98/37/EG, Annex II A
EG-Guideline Electrical Magnetically Amicability 89/336/EWG
EG- Guideline „Low Voltage“ 93/68/EWG

Machine:

PLANT: HVOF Equipment

TYPE: K2 Torch

PRODUCTION DATE: 2005

Project No. 780.000

CE

IS DEVELOPED AND DESIGNED ACCORDING THE ABOVE MENTIONED NORMS IN FULL RESPONSIBILITY OF

Incorporation: GTV Verschleiss-Schutz GmbH

Company Location: Gewerbegebiet, D-57629 Luckenbach, Germany

FOLLOWING STANDARDS:

- DIN EN 12100 Safety of equipment, components and machine units
- DIN EN 1050 Guidance for risk assessment
- DIN EN 60204-1 Electrical setup for equipment and machines
- BGR 500 Gases

THIS DECLARATION LOSES VALIDITY, IF CHANGES TO THE EQUIPMENT WILL BE DONE WITHOUT GTV AGREEMENT.

Luckenbach, 03.07.2008

Directory Manager

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1 GENERAL DESCRIPTION:

1.1 INTRODUCTION HVOF

Since it's first application 20 years ago, **H**igh **V**elocity **O**xygen **F**uel (HVOF) spraying has gained increasing importance in the thermal spray market.

The special feature of this technique, as compared to other TS techniques, is that the coating materials are less heated and impact on the components which are to be coated with remarkably higher velocities.

In HVOF systems a flame is created by combustion under high pressure, resulting in gas velocities of more than 2000 m/s. The spray powder is injected into this gas stream.

1.2 HVOF K2 SYSTEM

The HVOF K2 System is a HVOF System of the third generation. Instead of a fuel gas this system uses a liquid fuel (kerosene).

The system operates at combustion chamber pressure typically up to 10 bar. The powder is injected radially into the gas stream, just behind the point of divergence.

For the case of WC/Co powder, this system allows a spray rate of up to 10 kg/h without affecting coating quality.

Physical Comparison

Fuel	Max. Flame-temperature [C°]	Heat value [MJ/m^3]	Oxygen/Fuel Ratio For a max. Temperature	Oxygen/Fuel Ratio for a neutral flame
Propane	2800	93	4.5	5.0
Hydrogen	2900	11	0.42	0.5
Ethen	3000	60	2.4	3.0
Acetylen	3160	60	1.5	2.5
Kerosene	2800	38 MJ/l	2.9 [1)]	3.4 [1)]

1) mass ratio oxygen/kerosene

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During combustion of liquid fuel and oxygen chamber pressures of 10 bar and more are generated. This results in jet velocities of more than 2000 m/s. The generated heat is roughly doubled compared to gas operated systems. Temperatures of maximum 2.800℃ are achieved.

Using the ***GTV HVOF K2*** burner thermal spray coatings with low porosity (< 1%) high bond strength (> 100 MPa), low oxidation and high resulting hardness can be achieved.

Another advantage is that coatings with highly compressive residual stress can be sprayed reaching several millimeters thickness.

The power of the kerosene oxygen mixture is more than 250 kW (about 10 kW per liter kerosene). Thus feed rates of 10 kg/h can be realized.

1.3 WATER QUALITY

Use water with a low hardness (about degree 2 hardness).

Lime accumulation could damage the torch.

1.4 FUEL QUALITY

EXXSOL D 60

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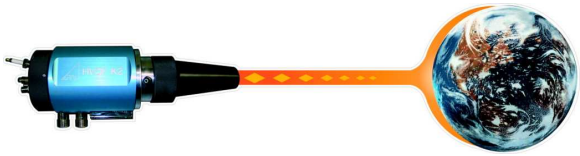

2 GTV HVOF K2 BURNER

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3 GTV HVOF K2 BURNER SPARE PARTS

GTV-no.	description
780.110-100	water jacket – 100 mm
780.110-150	water jacket – 150 mm
780.110-200	water jacket – 200 mm
780.111	o-ring water jacket
780.120-100	Intermediate sleeve – 100 mm
780.120-100 k	Intermediate sleeve – 100 mm conic
780.120-150	Intermediate sleeve – 150 mm
780.120-150 k	Intermediate sleeve – 150 mm conic
780.120-200	Intermediate sleeve – 200 mm
780.121	o-ring Intermediate sleeve
780.130	powder injector section
780.131	powder injector
780.132	screw
780.133	o-ring powder injector section (outside front)
780.134	o-ring powder injector section (outside rear)
780.135	o-ring powder injector section (inside front small)
780.136	o-ring powder injector section (inside rear)
780.137	o-ring powder injector section (inside front big)
780.140	main body
780.141	o-ring main body
780.142	t-clamp holder
780.143	screw for t-clamp holder
780.145	hand nut
780.146	screw
780.160	combustion chamber
780.170	rear body assembly

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780.171	o-ring rear body small
780.172	o-ring rear body big
780.180	atomizer connection
780.182	screw
780.183	o-ring atomizer connection big
780.184	o-ring atomizer connection small
780.190	spark plug
780.500	o-ring set
780.000	GTV HVOF K2 burner

expansion nozzle

GTV-no.	**description**	**diameter**	**length**
780.150-100/10	expansion nozzle	10 mm	100 mm
780.150-100/11	expansion nozzle	11 mm	100 mm
780.150-100/12	expansion nozzle	12 mm	100 mm
780.150-100 k	Expansion nozzle	conic	100mm
780.150-150/10	expansion nozzle	10 mm	150 mm
780.150-150/11	expansion nozzle	11 mm	150 mm
780.150-150/12	expansion nozzle	12 mm	150 mm
780.150-150 k	Expansion nozzle	conic	150mm
780.150-200/10	expansion nozzle	10 mm	200 mm
780.150-200/11	expansion nozzle	11 mm	200 mm
780.150-200/12	expansion nozzle	12 mm	200 mm

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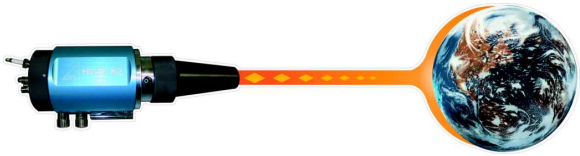
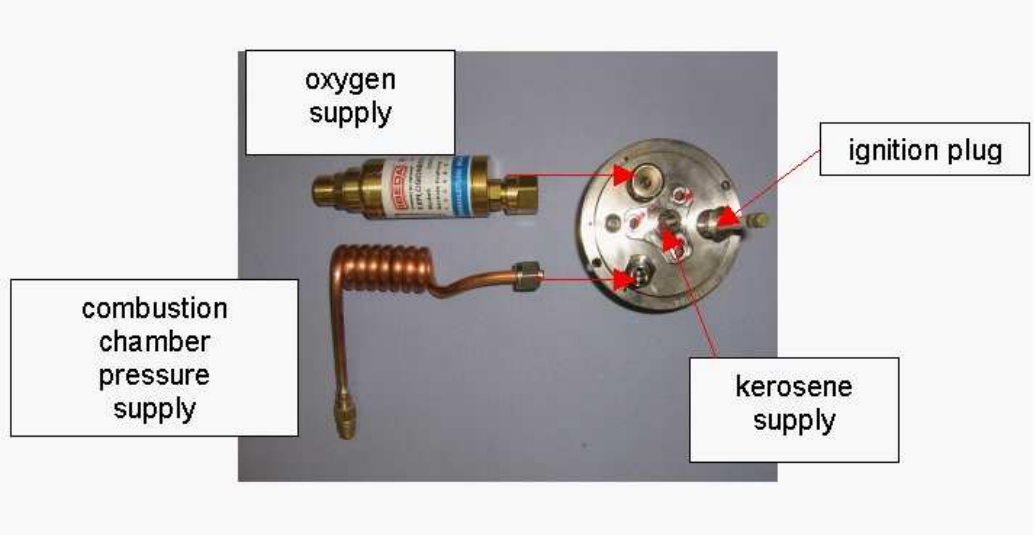


4 DISASSEMBLY AND ASSEMBLY OF HVOF K2 BURNER

Disassembly:

Before the HVOF K2 burner is disassembled, make sure that the system is shut down and the cooling system is shut down! There must be no water pressure on the gun!

1. Unscrew hose fittings for: oxygen gas, kerosene and chamber pressure. Disconnect cable to spark plug.



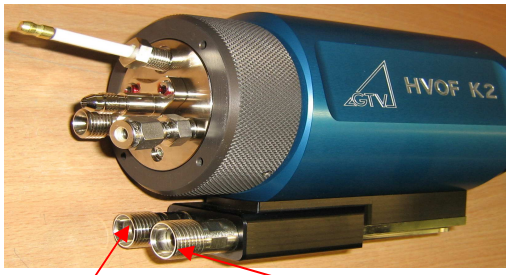
water supply

Lower circuit points

Return
Right-hand thread
780.148

Flow
Left-hand thread
780.147

Backward circuit points



Return
Right-hand thread
780.148

Flow
Left-hand thread
780.147

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2. Take HVOF Burner from manipulator and clamp burner with T-clamp into vise using aluminum pads.
3. Unscrew spark plug using spark plug tool.
4. Unscrew headless screws (3pieces) on locking ring. Unscrew locking ring.
5. Disconnect rear gun body together with combustion chamber.
6. Disconnect combustion chamber from rear gun body.
7. Unscrew water jacket using hands only.
8. Push out intermediate sleeve backwards.
9. Take off nozzle barrel out of intermediate section.

There is no tool necessary for step 5 –9!

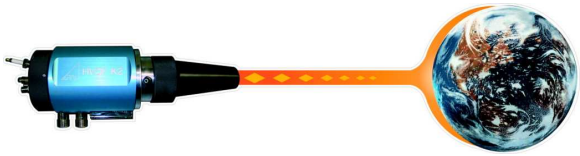
10. Unscrew both powder injectors using wrench SW 11.
11. Unscrew hexagon screws (6 pieces) of powder injector housing and disconnect injector housing out of the main body.

Assembly of HVOF Burner works vice versa!

Important note: First mount powder injector housing!

!! Danger !!

The HVOF K2 torch should only be connected and operated on a GTV designed plant. Otherwise any warranty expires as well as responsibility of GTV GmbH.



5 SERVICE

The HVOF K2 burner contains high precision mechanical parts and is designed for long term production use. Handle the burner carefully and maintain it at regular intervals (about every 50 operating hours) to guarantee a failure-free operation.

Wear parts like nozzles, powder injectors etc. are subject to shorter intervals, which depend on customers specific parameters and applications.

Suitable and economic service intervals must be found out by the customer.

Before the HVOF K2 Burner is disassembled, make sure that the system is shut down and the cooling system is shut down! There must be no water pressure on the gun!

Special attention must be paid to nozzle. Operating time may be very short, if carrier gas setting is not correct. Thus, right setting for carrier gas flow is very important.

5.1 CHANGING OF NOZZLE BARREL (NO TOOL USE)

- Unscrew water jacket by hand.
- Take out nozzle barrel out of intermediate sleeve and powder injector housing.
- Put in a new nozzle using O-ring lubricant - GTV O-Ring valve lube 112.111 ***(only lubricant permitted for use of oxygen!)*** **-** Apply lube slightly and put O-ring in. (***Caution: Conical shaped end to be placed into powder injector housing!)***
- Screw water jacket with intermediate sleeve on powder injector housing.

5.2 CHANGE OF O-RINGS

- O-Rings should be replaced after each leakage as well as disassembly due to safety aspects, because rings are subject to thermal load.
- Before new assembly of gun parts O-ring lubricant must be applied in any case using GTV O-Ring valve lube 112.111 **(*only lubricant permitted for use of oxygen!*)**.

5.3 CHANGE OF SPARK PLUG

- Unscrew spark plug using tool wrench.
- Screw in new spark plug slightly until resistance is build up by rear gun body. Do not over tighten!

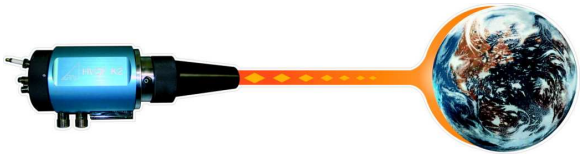
It must be ensured that the tip of the spark plug is 2 to 3 mm inside the rear body bore measured from the inside plane of the rear gun body!

5.4 CLEANING OF THE REAR BODY

Combustion residues accumulate after long-term use of the gun on the rear body.
From time to time the rear body should be cleaned with a brass brush.

Attention!
Do not damage the O-Rings when cleaning the rear body.

All bore holes must be free and not be blocked by impurities.



5.5 COMBUSTION CHAMBER (780.160)

Combustion residues accumulate after long-term use of the gun on the combustion chamber wall as well. Therefore the combustion chamber must be checked and cleaned in an ultrasonic bath, if necessary.

5.6 POWDER INJECTOR BLOCK (780.130)

The powder injector housing is a part, which wears out during powder feeding.
If there is significant erosion on the ring, in which the powder injectors are screwed, the ring must be rebuilt or the powder injector block must be replaced.

5.7 POWDER INJECTOR (780.131)

The powder injectors are also subject to wear. Wear becomes noticeable by magnification of the standard diameter. Standard diameter is 1.6 mm. If it passes over 1.7 mm, the injectors must be changed.
The powder injector must be screwed in the injector block. Do not over tighten. The injectors tips must stay inside their inner ring bores.

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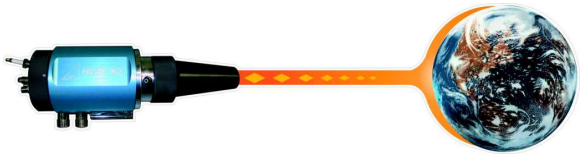

6 OPTIMIZATION OF CARRIER GAS FLOW

Before the burner is put into process again it must be ensured that correct powder carrier gas flow is adjusted.

The HVOF K2 burner shall only be used applying two separate controlled hoppers in order to ensure a homogeneous powder feeding.

- Start HVOF process and run burner on set values with no powder feeding.
- First apply high feed gas flow (about 15 l/min) feeding the powder from one side into the flame inside the gun barrel.
- Watch deflection of powder jet while spraying to test piece.
- Reduce feed gas flow until powder jet is traveling in the middle of the flame.
- Stop powder feeding of the first hopper. Do not change carrier gas value.
- Apply same procedure on hopper and gas line No. 2.
- Then run both hoppers and watch powder jet. Jet should be focused and not split into two jets.
- Correct carrier gas flow if necessary.

A spot spraying test on a test piece should show an ideal circular spray spot. If there is an oval shape of the spray spot no optimal powder injection is realised and causes significant reduced nozzle operating time.

If carrier gas flow is not set correctly within short operating time grooves will be formed in the nozzle barrel. Later water will pour into the nozzle.